Process Mining and Robotic Process Automation in Retail Banking: AI Applications for Systemic Operational Efficiency Enhancement

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1. Introduction

Artificial intelligence (AI) is increasingly being leveraged across the banking sector to enhance operational efficiency. The banking sector is fiercely competitive, and access to advanced technology is vital to maintain efficiency and competitiveness. The use of technological tools, particularly AI, has the potential to significantly reduce operational risk, increase efficiency, and lower costs. Currently, numerous factors create challenges to profitable banking: historically low interest rates, increased regulation, and reduced lending activity from a bank's own clients have all weighed on banks' profitability and created an urgent need to enhance operational efficiency. AI is the generic term for a number of 'smart' technologies that have the potential to transform the efficiency and effectiveness of most business operations, including banking. In many countries, AI-related technology investments are already competing with conventional IT spending.

This study focuses on assessing AI's applications and opportunities to enhance banking operational efficiency. It shows how AI applications are leveraged to carry out routine banking operations and analyzes AI systems for differential diagnosis of cloud computing clients. An image recognition deep learning AI system to support counterfeit currency verification is examined, and an AI application using an expressive word cloud visualization in automated insight generation to support bank CRM and market share analysis is presented. A rule-based fraud detection system that is suitable for operation in resource-constrained environments and in edge computing applications is assessed.

1.1. Background and Significance

Modern banking has seen a paradigm shift in the application of technology, right from the days of traditional banking transactions. The banking sector has evolved from a

conventional approach to embracing technology in its various operations. In recent years, artificial intelligence has not only found a place in science and engineering but has also become a core technique in finance and banking. It has brought radical changes in processes and systems in the banking sector. AI is a highly evolved field of computer science that makes machines learn to do tasks that usually require human intelligence. The traditional approach to banking has seen significant changes in the incorporation of technology on different fronts. At present, customers not only value the technology offered to them by banks, but they also expect banking staff to have the necessary tools to serve them efficiently and promptly. Operational efficiency is a term applied to maximum productivity with minimum connected costs in devising a product. In banking, operational efficiency mostly relates to a bank's capacity to deliver high-quality, prompt, personalized service to its clients at an acceptable cost, which is profitable for its stakeholders. Banks continue to face challenges that impact their operational efficiency, including the non-availability of real-time data, a technology legacy that is rigid and heavy, and government regulations. There are multiple factors compelling banks to improve their operational efficiency, particularly in a competitive environment where annual percentage rates, collateral coverage, funding facilities, liquidity ratios, and other traditional banking parameters mean little. The increasing importance of cost efficiency, scalability, reduced turnaround time, and enhanced productivity across all functions of the banking industry is calling for artificial intelligence and digital transformation. Whether it is profitability improvement, cost reduction, stronger risk assessments, or portfolio management, AI is beginning to make its mark in banking. In light of this background, however, it is still unclear how AI platforms such as machine learning or deep learning will deliver value across different banking activities. Thus, we seek to investigate how a range of AI technologies relate to the potential for improving banking operations.

1.2. Purpose of the Study

This study aims to explore potential AI applications from banking professionals' perspectives to enhance banking operational efficiency. This study aspires to bridge this gap in the existing literature using empirical findings from the responses of banking professionals. The study seeks to accumulate industry insights and has twofold aims. Firstly, to identify the use of specific AI technologies that can improve banking operational efficiency. Secondly, to provide banking professionals with well-instructed

strategies on implementing AI activities to leverage their operations. Through the insights obtained in this study, practitioners can have in-depth information on the adoption and implementation of AI technologies. This can also aid managers and banks together to advance their overall effectiveness and productivity. Overall, knowledge of the impact of AI implementations and its strategies is intended to contribute to the body of knowledge on AI and banking. AI advancements enable banking operations to be transformed, including reducing costs, automating activities, and utilizing agility. Artificial intelligence technologies have the potential to transform current banking practices. However, despite the promises of AI in enhancing operational efficiency, the literature on this topic is still unexplored. With an exclusive emphasis on the back-office operations of 14 banking activities, this study delivers evidence on the efficiency of technologies in terms of error mitigation, cost-cutting, and process reorganization. Consequently, the key goal of this study is to manifest practical and invaluable evidence on the potential of AI in improving the operation of banking services. Furthermore, the research assesses the most effective technologies, their efficiency, and the necessary changes in the organizational structure to support the AI solutions.

2. Understanding Banking Operational Efficiency

Banking operational efficiency portrays the extent to which banking institutions are established in order to reduce their costs per financial transaction. As a result, efficiency, the lack of waste, and the proper use of bank resources are the most important concepts in describing banking operational progress. An efficient bank is a high-performance bank. The effectiveness of banking institutions in some complexities strongly determines uniformity and activities and thus is a strong indicator of overall bank performance. Ensuring the availability of assets and professional staff from the workforce, such as having reliable technical software and hardware, can help streamline the banking operational process. In the application of appropriate technology for banking operations, banking customers, as experienced users, can enjoy better services, thus enhancing customer satisfaction and loyalty.

The efficiency of banks is denoted as a univariate. There are a number of factors. The survey concerns things that produce goods and services and their use over the same period. If a banking institution produces more services with some of the largest inputs, such as issuing, equipment, and other means, we say that banks are efficient. Financial

management at a banking institution is a value-added activity, which is part of operational processing, and there is also a group of products or services that are more valuable than wealth that has been used in a product. Implementation of other intelligence fields, on this occasion, is largely willing to cooperate to facilitate the management of financial products and save the flow of banking operations. The cohesive relationship between the essential components of the bank affects the quality of the overall bank operation. However, banks need to move with the changing times and customer demands and overcome hurdles in their service. To address these hurdles, it is essential for the bank to take the necessary measures in their day-to-day operations of the banking business.

2.1. Key Concepts and Definitions

Banks are trying every possible way to increase their operational efficiency through improved productivity, cost-effectiveness, risk management, as well as quality of service. Productivity improvement might result from capital that is directed by banks to the right uses of funds, such as mortgages or loans, which are less risky; thus, the margin of profit or loss also gets reduced. This could bring in funds, in relation to the capital employed, that will ultimately make the bank highly cost-effective and therefore more profitable. Cost efficiency, on the other hand, emphasizes reduction in cost to generate income in the most productive way. The key to such a statement is value; in this case, productivity leads to related value such as risk. The cost-income ratio provides a way of comparing the profitability performance of banks of different sizes. Research has shown that there is no general optimal microeconomic function for cost and profit, and therefore some minimal cost can be incurred to make some profit. It was observed, among others, that banks in West Africa had been experiencing a decline in return on assets but an increase in asset base.

Service quality, in this case, service quality and cost are not mixed issues together with operating efficiency. This is because it is possible for the services to be equally cost-effective without delivering to the required minimum of service. Thus, the end does not justify the means if banks that are both operationally efficient in terms of cost efficiency and service quality are to be achieved. Efficiency is very important; the implications include making it easier to trade shares, simplifying the credit ratings process, and achieving remote computer credit rating of bank shares with ease. In a nutshell, it

suffices to state that efficiency measures are important to guide management on policy issues and areas of operation that need further attainment of efficiency. It also provides an overview of what the customer expects from two banks in order to make an informed choice in relation to the prevalent market expectations of available banks. Information is important because it brings timely feedback regarding efficiency improvements. Efforts can be made to reduce and control these sources of inefficiency by turning optimistic suggestions into usable policies.

3. AI Technologies and Machine Learning Models in Banking

AI technology is a controlled intelligence shown by machines or software that can perform skilled human activity. The most popular AI technology in the banking field is natural language processing. Further technologies like computer vision, recommendation systems, knowledge reasoning, voice recognition, fraud detection, expert systems, investment robots, emotion recognition, and robotic process automation are widely used. A mix of such techniques forms an advantage for the banking sector to rapidly solve customer issues, control compliance, and enhance customer experiences. Machine learning models are computer systems formulated on the basis of data training and algorithms. Banks can use them to predict client actions, spot fraud, validate substantial losses, promote suggested systems, and much more depending on the capabilities of the machine learning models. Supervised machine learning algorithms are used to categorize clients' banking actions and consumer exposures.

Various supervised learning models, apart from basic models, include discriminant analysis, linear adaptable methods, weighted sampling, and RF anchored sampling among the types of machine learning models used. Unsupervised learning and semi-supervised learning methods are required to rectify the class identification defects in classified models. In order to forecast financial trends in detail, the principles of known methods use a small amount of input data to quantify consistency. In banks, every day, large amounts of data are delivered and gathered. In certain situations in numerous banking sectors, there is continuous growth in the amounts of data. To rapidly identify and produce possible good or poor data from a huge quantity of data, AI must be used. When a large quantity of data is processed, AI plays a major role in organizations. Banking data must be processed by AI for risk handling, customer satisfaction, and effective decision-making.

3.1. Overview of AI Technologies

AI technologies such as machine learning, deep learning, and neural networks have opened the horizons to new possibilities in smart decision-making. The value creation resulting from applying machine learning in banking and insurance is significant. Banking is information-intensive, and AI technologies can be used to fundamentally improve banking operations. Furthermore, technology allows for adopting a cognitive view of complex business problems. Using AI for reading data in banking results in an ability to adopt a new and improved perspective on risk management, compliance, loan origination, marketing, customer service, and day-to-day operations. The focus on the operations of AI data in learning technologies and natural language processing, as well as a wide range of combinations of capabilities, is noteworthy.

The initial exploration of AI technologies in banking helps illustrate what is being made possible by this new wave of smart decision technologies. At a fundamental level, it is important to be aware of the evolution in data analytics. At the turn of the millennium, banks started realizing the importance of advanced analytics to make sense of their transactional data. Down the line, they had the potential and were able to minimize the costs to go beyond just being aware and being predictive, leading to prescriptive modeling. Risk management, financial accounting, lending and customer segmentation, recommendation systems, and complaint and fraud detection were some of the domains in which predictive models help banks. In order to build complex levels of learning, neural networks greater than 8-bit are now made available. With wider and layered architecture, deep learning presents several basic advancements in research. Within the global banking industry, the kinds of artificial intelligence technologies coming under the umbrella of machine learning, deep learning, and neural networks, cognitive platforms, natural language processing, and robotic process automation are rapidly growing. Banking organizations are proposed to manage risky environments and numerous data breaches.

3.2. Applications of Machine Learning Models

Right from the 1960s, the banking sector has shown interest in substituting humans in industries like finance with machines to ensure faster and more efficient operations. In line with this, artificial intelligence, using diverse techniques like neural networks, support vector machines, and deep learning, enunciates features of the training data and

builds a system to recognize patterns, as seen in entities and relationships among constituent elements. These models help to extract canons and facts that streamline the banks' operations. Machine learning models can predict better customer profiles, behavior, and preferences. This application has shifted the focus from who to say "no" to who deserves more. In this tone, banks can now create personalized marketing campaigns targeting diverse segments. For instance, analytics can quickly identify who is a defaulter and who applies for loans for their cars and shopping sprees.

4. Case Studies and Success Stories

ABN Amro United Emirates, a leading bank in the United Arab Emirates, recently adopted an AI virtual employee called "AINA," who offers information about the bank's products in branches through voice recognition. AINA is an innovative application of AI in this one use case in the bank.

OCBC Bank in Singapore has also transformed its commercial operation credit to make it more efficient for staff, as well as improve the mean time to decision, that is, to reduce the time it takes to make decisions on commercial loan applications.

The Commonwealth Bank of Australia turns data into customer value and operational technical innovation, with the aim of becoming "a truly digital bank." For example, they have internal credit scoring as part of their credit card profit protection system that is more predictive in identifying future delinquency than the traditional credit score. With a key focus on operational efficiency, they have an app that allows you to get $50 in less than 60 seconds. By combining data on banker behavior and chat client interactions, they have been able to reduce technology incidents while also improving customer satisfaction with the service.

However, the application of AI in the bank comes with significant challenges. Some of these that have presented themselves to the Commonwealth Bank were how to stop AI models from falling in their performance, what social robots would be seen as ethical and trustworthy by customers, and how to help project teams operate in an agile manner. At the Commonwealth Bank, a key driver is to ensure that we remain on the cutting edge of advances from machine learning and data science to take advantage of our vast amounts of client and transaction data, and constantly improve customer and patient value through AI.

4.1. Real-world Examples of AI Implementation in Banks

A few banks have already succeeded in implementing artificial intelligence and machine learning in various parts of their activities and are reaping the rewards. For instance, one program processes documents within seconds rather than the 360,000 hours that it would normally take for people to do the same task. The program is used to review loan agreements and is programmed to review documents in up to 300 different ways, to see whether the agreements include requests such as taxes or insurance. Another bank has also worked on an application; a chatbot that has been implemented by their customer-facing staff as well as on their website and provides services such as account balances, e-commerce features, and things like serving as a virtual assistant for their credit card. The chatbot uses a personality built by a chief storyteller and records customers asking questions. It has to tell a story, has a question, and looks up algorithms to provide the information. One bank has employed a virtual assistant to help with the processing of stalled home equity lines of credit. The bank employs humans to process the stalled home equity applications, but the virtual assistant now gets a significant percentage of first calls for the bank's call centers, equating to almost 800,000 inquiries. Meanwhile, in another country, a financial group is implementing a robot to take over front-of-house duties in the banks while telling jokes and visiting nursing homes to visit the bank's customers.

In addition, there are many different operational efficiency improvements that some of these banks have implemented using machine and deep learning. These advancements include fraud and risk management, compliance validation, cross- and up-selling, customer risk, customer satisfaction, and enhanced marketing spend or ROIs. For example, a digital bank is able to combine a large variety of sources, learning from many industry players and not just its own. The different capabilities give them insights into the desk with several personal characteristics and the capacity to predict personal behavior rather than simply the ability of a score to predict portfolio-level interest rates. The increase in accuracy has reduced its interest rates while maintaining risk at an even lower level than others. It claims traditional banks would take many years of data on machine learning progress to achieve the same risk-return profile, while they can do it with a fraction of that time. The bank received an equity fund injection after many years of being in business.

5. Challenges and Future Directions

Challenges Although integrating AI technologies into banking operations can result in improved operational efficiency, reduced fraud and error, increased profit margins, and more satisfied customers, there are some challenges as well. The data that AI systems analyze may contain confidential information, which can increase concerns about data privacy. Banks must take care to either anonymize data or ensure their data systems comply with the strictest data privacy regulations anywhere in the world, which is likely to mean either the GDPR in Europe or the upcoming California Consumer Privacy Act in the United States. Moreover, multi-jurisdiction operations and the sharing of data between banks in different countries open up the complex world of international data access, which has problems of its own. Relatedly, AI systems must be regularly reviewed to make sure that they are not inadvertently facilitating any kind of discrimination, which is important not only in terms of societal values but is also required by banking compliance. Furthermore, banks need to have highly skilled individuals available to support and manage AI systems to ensure they don't go astray in their decisions.

Banks are facing numerous hurdles in the identification, acquisition, assimilation, and positioning of AI platforms. One of the weaknesses of AI is its tendency to focus on correlations rather than causality. Moreover, correlation does not necessarily mean causation. Real-world events are also complex because sometimes they do not have a single cause but are the result of a complex conjunction of causes. Finally, AI today is not a panacea: it has limitations and is not able to clarify situations where human judgment is based on multiple skills and knowledge. As awareness of the problem of defining liability and regulation in new contexts in the field of ethics and technology has been observed, more and more regulatory bodies are becoming answerable. The area of continued focus on compliance will be beneficial to the AI model and would optimize the resource allocation of financial institutions. However, financial institutions need requisite adaptive and proactive initiatives to maintain a competitive edge in an increasingly dynamic technological landscape and law and regulation.

5.1. Current Challenges and Limitations

5.1. (a) Current Challenges and Limitations

5.1.1. Data Security and Privacy Threats Unfortunately, despite significant advancements in technology, there are still many aspects that need to be tackled before AI becomes mainstream for banks. For instance, data security and privacy is one of the aspects that continue to restrain banks from adopting AI. Data security, especially within banks, is always a major issue, and this issue increases with the larger extent of outside regulations and consumer backlash. Consumers are concerned about their personal and financial information being shared with others and the violation of their privacy. As a result, there are significant implications for banks trying to implement AI solutions when customers and the public are already alarmed and referring to financial institutions as the "bad guys."

5.1.2. Lack of Reliable Data It is well known that the use of AI-based techniques requires a deep understanding of the domain. This relies on having reliable, representative data to train it using approved algorithms and data lakes. One of the other major issues of AI for banks today is the lack of this data, which is particularly important in a banking-specific shopping facility.

5.1.3. Resistance to Change The main challenge for physical banks remains the productization of new data insights and the change in thinking that is required at the top. There is considerable resistance to change not just from a cultural perspective, but also from companies that are not familiar with working with relatively young technology startups. As a result, even where top managers at banks are intrigued by the potential use of AI, there is a worry that the technology and the lack thereof might make them look bad. Furthermore, end users of such banks may not want the change and could end up leaving the lender altogether. Banks show signs of such resistance to collaboration, particularly in the open banking space. While personal finance startups have talked down the regulation as being little more than a means to make them more powerful, traditional banks have had their own criticism of the technology upstarts and view it as cumbersome.

5.2. Future Trends and Opportunities

Artificial intelligence is continuously advancing; different techniques and tools display the future use of AI in the banking sector. We believe this survey will present invaluable insights for banking professionals to shape the future strategy of their organizations proactively. The continuously evolving fields of machine learning and neural networks

are expected to bring revolutionary changes in applying AI to upgrade the operational efficiency of banks in handling their routine transactions, including other AI applications where advancements are expected to occur. As we could observe, whether it is chatbot, deep neural network, neural language processing, or robotic process automation, such AI applications will reduce errors and paperwork and will automate the process, minimizing time taken by employees while increasing the efficiency of the banks.

Personalization will set the trends in the ongoing years with more and more banks relying on machine learning and user search results to customize and personalize their interactions. Due to blockchain's unique verification protocol, it is easier for banks to streamline their operations and reduce risk. Banks as crypto-friendly and as crypto-packaged are aware that cryptocurrencies are a significant innovation and a sign of changing times. Also, the shift of customers from traditional to crypto banks and from crypto to traditional banks means that the future is hybrid, and that is why innovation in this area may break new ground for banking industries. Future opportunities lie in this area, as this can be a very new approach in technological terms. The findings and opportunities emphasized further instill the idea of continuous learning. While the area of artificial intelligence continues to diversify, making it tough to predict future trends, banks should be poised to recognize forthcoming opportunities to enhance and streamline their operations and identify future areas of development.

6. Conclusion

By applying artificial intelligence solutions banks can improve their operational efficiency. Inclusion of AI can help bank management understand the latest technological advancement and also to understand challenges facing AI based applications. The study found that successful AI adoptions cost money and time, but through re-engineering banks can achieve substantial increment in customer service and profitability. Furthermore, the study uncovered some lessons from the case studies which were useful in identifying where and how AI can be implemented in banking. Strategic management, creativity, and innovation are essential tools to be utilized at the strategic level in the bank to attain the desired competitive advantage.

No single-purpose technology has driven the level of unwarranted expectation that has been associated with artificial intelligence. Case studies dispel the notion that AI is

significantly more advanced than other, equally viable development alternatives. There is no substitute for strategic planning and continuous innovation. The success of AI depends on technological, organizational, and environmental factors. The banking industry should undertake the above mentioned important issues of AI to exploit its potential full implementation and be more competitive. No one can ignore AI if he wants his organization to survive. Banks are often advised to take steps that are based on intelligent reflection about their competitive priorities, capabilities, and the options open to them. The purpose of this paper was to report on a study; through the use of case interviews of managers in financial institutions, to examine the perceptions of the significance of the application of AI in banking and to discover how it can help in decision making and improve operations. This provides a broad understanding of the views held by the banking sector regarding AI. The contribution to knowledge is based on the fact that the issues of AI from broad perspectives were scarcely found in the finance literature.